DOCUMENT RESUME

ED 373 970 SE 054 561

AUTHOR Spyker, Geert; Malone, John
TITLE Curriculum Reform: Difficulties Experienced by Teachers in Implementing a New Statewide Mathematics Curriculum.
PUB DATE [93]
NOTE 9p.
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Educational Change; Foreign Countries; Grade 11; Grade 12; High Schools; Mathematics Instruction; *Mathematics Teachers; Questionnaires; *Secondary School Mathematics; *Student Attitudes; Student Role; *Teacher Attitudes; *Teacher Role
IDENTIFIERS Australia (Western Australia); *Reform Efforts

ABSTRACT

This paper discusses a study that examined the establishment of a new senior high school mathematics curriculum into schools in the State of Western Australia. Two aspects of change are discussed: (1) the extent to which the reconceptualization of the pedagogical approach to teaching mathematics encouraged in the reform was taken up by teachers, and (2) the effect it had upon the student body. Senior high school mathematics teachers (n=400) completed a questionnaire that dealt with changes in pedagogy, adoption of methodological changes, teacher attitudes and opinions, and teacher actions regarding change. Surveys were also given to 11th- and 12-grade students (n=1,550). Results showed students to be conservating in their views of the changes, but they agreed with their importance. Contains 16 references. (MKR)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED 373 970

Curriculum Reform:
Difficulties experienced by teachers in implementing a new Statewide mathematics curriculum.

Geert Spyker and John Malone,
Science and Mathematics Education Centre,
Curtin University.

Objectives

The purpose of this study was to conduct a comprehensive examination into the establishment of a new senior high school mathematics curriculum into schools in the State of Western Australia. The focus was on the *how* of curriculum change as well as the *why* and the *what*. Specific areas of interest included: reasons for the curriculum reform; nature of the changes; the dynamics of implementation, and the outcomes - its success or otherwise.
This paper will be confined to two aspects of the change - that of the extent to which the reconceptualisation of the pedagogical approach to teaching mathematics encouraged in the reform was taken up by teachers, and the effect it had upon the student body.

Background

Western Australia, with a current population of 1.8 million people, was founded in 1829 and is the largest of the six States and two Territories which comprise the Australian continent. Because of Australia's historical links with Great Britain, mathematics curriculum development was originally modelled upon British ideas (Clement, M, 1989; deLaeter, 1989). From the mid-1960s onwards, however, Australian mathematics education turned away from the traditional British model, although the influence of the Cockcroft Report: *Mathematics Counts* (1982) was enormous, particularly where it addressed issues pertinent to the teaching of mathematics in Australian schools (Stephens, 1984). The impact of developments in the United States which produced publications such as the National Council of Teachers of Mathematics (NCTM's) *An Agenda for Action* (1980) became increasingly stronger on Australian mathematics education, particularly, in the post-Sputnik space race era where curricula were developed which produced ideas and materials which could not be ignored. More recently in Australia, the NCTM's *Curriculum and Evaluation Standards* (1989) has had a profound effect on curriculum development here.

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
☒ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

1

BEST COPY AVAILABLE

2

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
G.M. Spyker
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

SEC 534 501

Traditionally, the mathematics curriculum taught in schools in the different Australian States and Territories has been decided upon and produced in either one of two places : the elementary and middle-school curriculum by State Education Departments, and the senior high school curriculum by State Public Examination Boards acting on the advice of Mathematics Syllabus Committees whose members include both high school and tertiary mathematics teachers (Malone, 1992).

Commencing in 1988, the State of Western Australia instituted dramatic changes to its mathematics syllabi at the senior high school level, motivated by the number of students staying onto school beyond the compulsory attendance age of 15 years and the consequent variance in ability levels; the need to revise and replace out-dated content; the need to review traditional views on pedagogy, and the need to attract more students (particularly females) to study mathematics. Six years later, the new mathematics curriculum has been implemented. This paper will focus on just two aspects of the change - the first, an evaluation of pedagogical changes encouraged within the new curriculum : what this change involved, how it was "sold" to teachers, the degree to which it was taken up, and the success or otherwise of the innovation, while the second assesses the impact of the changes upon students.

The present decade saw the publication in this country of the *National Statement on Mathematics for Australian Schools* (1991), which aims to give direction to mathematics education across the Australian borderlines and to promote collaboration between the states. Its aim is "to provide a framework around which systems and schools may build their mathematics curriculum, and it identifies important components of mathematics education for the majority of students. It is descriptive rather than prescriptive, does not provide a syllabus or curriculum and, indeed, possesses a structure which makes it inappropriate for direct use in that way." (p. 1).

Theoretical framework.

The revised Western Australian mathematics curriculum aimed to "present mathematics as an organised body of useful knowledge and provide students with the skills and confidence necessary to apply this knowledge in practical situations" (Secondary Education Authority, 1989, p.1). Some of the stated objectives of the courses are that "students will communicate mathematical ideas and results, in both oral and written forms; compare outcomes with expectations and verify the suitability and reasonableness of a result". The guidelines go on to say that "it is highly desirable that students interact in a constructive and cooperative manner with peers and teachers and respond constructively to advice" (p.3). This was to be achieved not only by the change in curriculum

content, but also by a change in the approach to teaching and learning so that both high achieving and low achieving students would benefit.

Now for any innovation to be successful, the changes must be carefully prepared, more so if the changes are at the State level, and even more so if it involves a reconceptualisation of traditional approaches to teaching. For that reason teachers must understand why pedagogical changes are necessary and be convinced of the viability of these changes so that they can commit themselves to implement them (Tobin and Imwold, 1992). Giacquinta's (1973) description of the three stages in introducing a new program into schools (initiation, implementation and incorporation) is still relevant today, particularly his statement that successful initiation does not necessarily mean the successful implementation of the innovation. There may be many discussions and great enthusiasm about an innovation, but if teachers' and students' behaviour do not change and if teachers do not accept the pedagogical philosophy underpinning this innovation then the implementation has no effect. Rejection of a new scheme is not only based on the personal characteristics of teachers, but is often influenced by organisational features, politics of change and the type of change (Waugh & Punch, 1987).

While the new content aspect of the revised mathematics curriculum in Western Australia was well handled with a variety of publications, workshops and professional development activities for teachers, the same cannot be said about the pedagogical aspects. The new approach was patently constructivist (von Glasersfeld, 1990) and teaching interpretations in line with constructivist ideas (for example, group work, problem solving, reflection, student/teacher consensus, student/student and student/teacher discussion) were encouraged. The first part of the study examines the extent to which these aspects of the change were accepted and adopted by the teachers, while the second part considers the impact upon the students.

Methodology

Several research questions provided a focus for the study:

- What were the principal changes in pedagogy inherent in the new approach?
- To what extent were the methodological changes adopted by teachers?
- What were teachers' atutudes and opinions towards the changes?
- What were the teachers' actions regarding the changes?
- What were the students' experiences with respect to the new courses?

A qualitative approach (Erickson, 1986) was the principal methodology adopted for this study. Data sources for the interpretative aspects included the following: interviews with teachers, teacher educators and Ministry of Education officials; observations of 30 teachers conducting mathematics lessons in class, and interviews with 100 of their students. Assertions were developed by the researchers from the field notes recorded during observations, and confirming/disconfirming evidence was sought in subsequent observations and in interviews and discussions with teachers, students and school administrators. Qualitative data was analysed with the assistance of the NUDIST program (Richards & Richards, 1990) in order to develop a grounded theory of subject/curriculum relationships. This theory was to be built on concepts derived directly from the primary interview data collected.

A quantitative element was introduced through the use of a questionnaire developed for use with a more broadly based sample of teachers. Approximately 65% of the senior high school mathematics teachers in both government and non-government schools in Western Australia who initially indicated their willingness to participate in the survey completed the questionnaire (n=400). The information derived from this source was considered in conjunction with the other qualitative data collected.

Concurrent with this teacher survey, approximately 900 Year 11 and 650 Year 12 students completed a questionnaire in which their opinion was asked about reasons for selecting mathematics in general and specific mathematics subjects in particular; factors which they associated with their success in mathematics, and people who they consider most influenced their choice of mathematics.

A visit to The Netherlands enabled one of the researchers to discuss the similar implementation of new mathematics courses in Dutch high schools. These courses are based on the *realistic* approach to mathematics education (De Lange, 1987) which has a strong affinity with constructivist ideas. Educators who are proponents of this *realistic* approach were interviewed while approximately 25 classroom lessons were attended with the aim of determining how far this new approach to education has been adopted. Discussions with the teachers involved provided good indicators of their personal views, and this cross-cultural aspect of the study constituted a useful pilot for the teacher interviews in Western Australia.

Results

Teacher Survey

The Teacher Survey dealt with the first four research questions.

(a) *What were the principal changes in pedagogy inherent in the new approach?*

A careful survey of materials prepared for teachers and interviews with the teachers themselves indicated that ideals such as student autonomy, student-centered rather than teacher-centered activity, reflection, classroom consensus on mathematical issues through negotiation, and the withholding of direct answers to student questions by the teacher were encouraged although the term *constructivism* was never used in these materials. In our interviews and in the questionnaire teachers were requested to indicate their intended support or opposition to these ideals. Their responses showed a strong commitment in promoting teaching strategies where students are given time to reflect upon what has been taught, are encouraged to demonstrate their methods and solutions to the rest of the class, and are encouraged to comment on other students' methods and results. The teachers also indicated that they were more interested in the students' method of solution than in their final answers. There was divided support for promoting small-group work in the classroom.

(b) *To what extent were the methodological changes adopted?*

In this study it was clear that teacher cooperation was strongest when implementing syllabus content changes, undoubtedly because in-service courses and workshops which were available enabled them to seek assistance regarding any problems they faced. It became apparent, however, that in general these workshops dealt with new contents for various courses while insufficient attention was paid to new teaching strategies. Many teachers indicated that they did attempt the suggested reforms but would switch back to traditional methods frequently in the interest of class discipline and as a result of pressure from colleagues, parents and administrators. Change has proved to be difficult to implement because teachers are inclined to maintain well-tried strategies which they have developed. Obviously, changing existing strategies cannot be achieved after a few in-service courses but require a personal commitment of teachers over a long period of time.

(c) *What were teachers' attitudes and opinions towards the changes?*

Many teachers rejected the majority of the constructivist thrusts, again in the interest of discipline and their responsibility to ensure that students completed the syllabus and were successful at examinations. This resistance was evident among both young and older teachers.

In general, teachers agreed that the new courses were beneficial for the students because of a greater choice of suitable subjects, and they considered that the standards of mathematics in comparison with the previous courses had not been lowered. Opinions were divided with respect to personal benefits because of the extra work involved to familiarise themselves with the new

courses. The same applied to an improved effectiveness of teaching after introducing new strategies. A strong wish was expressed in favour of future stability in the curriculum: using the new courses for many years to come.

(d) *What were the teachers' actions regarding the changes?*

The researchers are currently working in a one-to-one relationship with a sample of teachers and have achieved some initial significant results with a number of them. A majority of the teachers in the sample are becoming convinced that many elements of the new approach have the potential to improve students' understanding of mathematics and are striving to adapt their existing approaches to teaching to conform with the new approach. Overall, our results support those of Waugh (1993) in that they emphasise the importance of teachers' *attitudes* to a change in curriculum if such change is to be successfully implemented.

Other relevant findings of the study established that system-wide change is better received by teachers if :

- they can participate in decisions relating to those aspects of the changes that affect their classrooms and school;
- the ratio of investment to return relating to the work they have to perform to implement the change is worthwhile for them and their students;
- they receive support from their superiors and colleagues;
- the change which is promoted is clearly perceived to have some potential to overcome the deficiencies and problems inherent in the existing system;
- concerns regarding change can be raised with persons who can do something about them.

Student Survey

The survey of over 1500 students at Years 11 and 12 level produced some interesting results.

(a) Students were found to be conservative in their views of the changes. Their goal, along with that of their parents (and, frequently, school administrators) was to achieve a satisfactory result in a final school or public examination. Any situation or event which appeared to bring this goal closer to attainment was viewed favourably by them.

(b) It became clear that one of the main reasons why senior high school students take mathematics in general and certain mathematics subjects in particular was utilitarian: they need it for a job or study after completion of their high school studies.

(c) The students' reactions to some of the constructivist thrusts of the study revealed that they agreed with the importance of being able to interpret problems properly and asking questions in

class. Their opinions were divided over the importance of group-work in the classroom, while they disagreed with the importance of having access to a computer during mathematics lessons. They did appreciate the opportunity to discuss real-life mathematics problems with fellow students.

(d) The students indicated that their success in mathematics greatly depended upon their teacher who they preferred to explain things clearly, make the subject exiting, and treat them as "real people".

(e) The fact that their friends studied the same subjects played no part in their own choice of subjects.

(f) The Year 11 students indicated that their parents and mathematics teacher had the greatest influence in their choice of mathematics subjects, while the Year 12 students showed a greater independence by indicating that they had made the choice themselves, with the influence of parents being of secondary importance.

Conclusions

The results of this study highlight the difficulties experienced by teachers during the implementation of a new mathematics curriculum and illustrates the efforts which can be applied to render the implementation effective. The study also demonstrates the dilemmas teachers experience and the obstacles they must overcome as they deal with the task of familiarising themselves with the new concepts and approaches required. The study will be informative for teachers about to undergo similar curriculum innovation and will be of value to educators and curriculum planners in future curriculum development. It emphasises what students expect from their mathematics teachers and from school in general while they show limited interest in ways and means to reach their ultimate goal of graduation. In a more general sense, this study places the current development of mathematics education in Western Australia in a worldwide perspective.

References

Australian Education Council and Curriculum Corporation. (1991). *A National Statement on Mathematics for Australian Schools.* Carlton: Curriculum Corporation.

Clement, M.A. (1989). *Mathematics for the minority.* Melbourne, Deakin University.

Cockcroft, W.H. (Chairman). (1982). *Mathematics Counts.* (Report of the Committee of Inquiry into the Teaching of Mathematics in Schools). London, HMSO.

De Laeter, J. (1989). The influence of American and British thought on Australian secondary physics education. *Science Education*, 73, 445 - 457.

De Lange, J. (1987). *Mathematics, Insight and Meaning.* Utrecht: VOWO.

Erickson, F. (1986). Qualitative methods in research on teaching. In M. Wittrock (Ed.), *Handbook of research on teaching*. pp 119-161. New York: Macmillan.

Giacquinta, J. B. (1973). The process of organisational change in schools. In Kerlinger F.N. (Ed.) *Review of Research in Education*, 1, 178-208.

Malone, J. (1992). Mathematics education in Australian schools. In Morris, R. and Arora, M.(Eds). *Studies in Mathematics Education*. UNESCO, Paris.

National Council of Teachers of Mathematics. (1980). *An Agenda for Action*. Reston, Virginia: NCTM.

Richards, T. & Richards, L. (1990). *Manual for mainframe NUDIST*. Eltham: Replee.

Secondary Education Authority, (1989). *Mathematics for Year 11 and 12*. Perth: Government Printers.

Stephens, M. (1984). Mathematics Counts: An Australian Response to the Cockcroft Report. *Australian Mathematics Teacher*, 40(1),8-10.

Tobin,K. and Imwold,D. (1992). The mediational role of constraints in the reform of mathematics curricula. In Malone,J. and Taylor, P.C. (Eds). *Constructivist interpretations of teaching and learning mathematics*. Curtin University, Perth, Western Australia.

von Glasersfeld, E. (1990). Constructivism: Some like it radical. In Davis, R., Maher, C. and Noddings, N. (Eds). *Constructivist views on the teaching and learning of mathematics*. National Council of Teachers of Mathematics. Reston, Virginia.

Waugh, R.F. (1993). Teacher receptivity to system-wide change in the implementation stage. *British Educational Research Journal*, 19(2).

Waugh, R.F. and Punch, K.F. (1987). Teacher Receptivity to Systemwide Change in the Implementation Stage. *Review of Educational Research*, 57(3), 237-254.